SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

Injection molding process is the predominant method for producing plastic parts. Injection molded parts like handset casing are best designed through use of injection molding computer simulation because it can save the time and cost. The development of handset casing needs the optimum manufacturability parameters to maximize the quality of the products at lowest cost and highest productivity. There are many defects occurs at finished products when the parameters not defined precisely. This project is to investigate and defined the optimum manufacturing parameters of handset casing using a computer simulation. After reverse engineering of the selected product, the manufacturability parameters will be determined after the properties of product was determined. The properties of the products and manufacturability of the product will be defined using CAE tools and Moldflow Plastic Insight (MPI).

ABSTRAK

Proses suntikan acuan adalah lebih menonjol untuk penghasilan produk plastik. Produk suntikan acuan seperti bekas telefon bimbit adalah terbaik direka melalui simulasi computer suntikan acuan kerana menjimatkan masa dan kos. Pembangunan bekas telefon bimbit memerlukan had-had pembuatan yang optimum untuk meningkatkan kualiti pada kos yang rendah dan produktiviti terbanyak. Banyak kecacatan berlaku pada produk siap kerana had-had tidak ditakrifkan secara tepat. Projek ini bertujuan menyiasat dan mentakrifkan had-had pembuatanyang optimum melalui simulasi komputer. Selepas melakukan pembalikan kejuruteraan pada produk terpilih, had-had pembuatan akan dikenalpasti. Sifat-sifat produk akan dikenal pasti melalui kejuruteraan bantuan computer (CAE) seperti Moldflow Plastic Insight.

ACKNOWLEDGEMENT

Grateful sense goes to Allah, The Most Beneficent and The Most Merciful on His blessing until this thesis produced properly. With a deep sense of gratitude I would like to express my sincere thanks to my supervisor, En Mohd Rashidi Maarof for his attention to guide me on doing this project thesis as well. Thank you too to other lecturers and staffs who help me in this project.

I am appreciates my parents supports, my brothers and my friends who involved during this project done. Thanks a lot. To mother and father, your pray is very meaningful to my life.

I had tried my best to apply the knowledge that you delivered and I hope this can show my full commitment about the project. I am also happy to present everybody who ever involved in one way or another, made significant contributions to various process of this project. I hope I can learn something from this project and everybody can understand all the input inside this thesis.

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INTRODUCTION

1.1 INTRODUCTION

The use of plastic material has grown phenomenally during the last several decades. Application are continually expanding and include both replacement of parts made of more traditional material and creation of new products that otherwise would be impractical, if not impossible to produce without plastics. Handset casing is a one of the applications of the use of plastic material.(Beaumont,2002)

The injection molding process is the predominant method for producing plastic parts. It provides significant advantages over many alternative manufacturing methods use with either plastic material or other competitive materials. This is particular true in the case of product that is to be produced in large quantity. The injection molding process offers the ability to produces parts in large volumes, quickly, with precise detail, excellent repeatability and at minimum cost.

The injection molded parts are best designed through use of injection molding simulation. These programs provide the unique opportunity to evaluate mold filling, packing, cooling, product shrinkage, warpage and structural characteristic before a mold is ever built. The software is useful in simulating and visualizing the performance of the injection molding process. Thus, the competitive edge between competitors is done at lowest possible cost.

1.2 PROBLEM STATEMENT

1.2.1 Problem

Plastic injection molding is one of the most important polymer processing in plastic industry today. However, to produce precise plastic part like handset casing, it need a high skill in mold making and injection molding machine control. Nonaccurate parameters will lead to the defects in product or mold. This can affect the productivity and the production will suffer the high loss.

1.2.2 Solution

To develop a handset casing, there are many manufacturing parameters need to investigate in order to maximize the quality of the casing at the lowest cost and highest productivity rate. There are many defects occurs at finished product when it is ejected from injection mould because the manufacturing parameters was not defined precisely or at optimum condition.

1.3 OBJECTIVE

To investigate manufacturability of handset casing using computer simulation

1.4 SCOPE OF WORK

(i) Do the reverse engineering of selected product

(ii) Use the CAE tool (Moldflow) to investigate the manufacturing parameters.

(iii) Recommend improvement design (if any)

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The objection of design concept for an injection –molded thermoplastic part with a thin shell feature in the computer, communication and consumer electronic product have more space for the tightly packed components. Therefore, the wall thickness of the housing parts will reduce to 1mm or less in thickness from the original of 2-3mm in thickness. [2]

2.2 REVERSE ENGINEERING

While conventional engineering creates a CAD model based on the functional specifications of a new product, reverse engineering uses a manufactured part to produce CAD model. [3] Reverse engineering typically starts with measuring a physical object to reconstruct a CAD model for applications. [4]

The most critical part of reverse engineering is the segmentation process because it seriously affects the quality of the resulting CAD model. To improve the quality of segmentation, it is essential to make use of features (sharp edges and symmetry planes). [4]

2.2.1 Solidworks

SolidWorks recently emerged as one of the 3D product design software for Windows, providing one of the most powerful and intuitive mechanical design solution in its class. In SolidWorks, parts are created by building a “base feature,” and adding other features such as bosses, cuts, holes, fillets or shells. The base feature may be an extrusion, revolution, swept profile or loft. To create a base feature, sketch a two dimensional geometric and move the profile through space to create volume. Geometry can be sketched on construction planes or on planes surfaces of parts. Feature-based solid-modeling program are making two-dimensional design techniques obsolete. [5]

2.2.2 Autocad

Besides the basic function, there are several features of AutoCad that greatly expedite the geometry construction. [6]

AutoCad stores the coordinates of all objects in drawing I a fixed reference frame known as the ‘World Coordinate System”. In the WCS, the X axis is east-west, the Y axis is north-south, and the Z axis. In addition to the WCS, it is possible to create one or more Users Coordinate System (UCSs), which involve a temporary shift of the origin point and orientation of X, Y and Z axis. Control of the coordinate system is provided by the UCS command. Autocad uses the standard mathematical convention for angles, with 0° along the positive X axis and positive angles measured counterclockwise. [7]

The integrated CAD system is composed of an input and shape treatment module, a production feasibility check module, a blank –layout module, strip layout module, die layout module and drawing edit module. [8]

2.2.3 3D Plotter

3D Plotter is a type of Coordinate Measuring Machine (CMM). CMMs have become very powerful parts of measuring tools. The CMM is a Cartesian robot, which has a touch-trigger probe in place of a gripper. They are CNC machines, flexible and repeatable for the faster measurement of real parts. CMMs are used in surface and boundary continuous probing or scanning of parts as well as the extraction of geometric feature data from point cloud data. The number of measurement touch point is determines by CMM according to the curvature change of the part surface measured on the tactile point. The measurement result are in suitable digital form, which unlike analog data, necessitate no further process. [9]

2.3 MATERIAL

2.3.1 Acrylonitrile Butadiene Styrene (ABS)

ABS plastics are two-phase system. Styrene- acrylonitrile (SAN) forms the continuous matrix phase. The second phase is composed of dispersed polybutadiene particles, which have a layer of SAN grafted onto the surface.[10]

ABS offer superior processibility and appearance as well as low cost, along with good balance of engineering properties.

Table 2.1: General properties of Acrylonitrile Butadiene Styrene

General properties of ABS	
Specific gravity	1.05
Tensile modulus @73 °F (MPsi)	0.3
Tensile strength @yield (Kpsi)	5.0
Notch izod impact @73 °F (ft-lb/in)	2.5-12.0
Thermal limits service temp (°F)	167-185
Shrinkage (%)	0.4-0.7
Tg(°F)	185-240
Process temp, (°F)	410-518
Mold temp(°F)	122-176
Drying temp(°F)	176-185
Drying time (s)	2.0-4.0

Source: Campo (2006)

2.3.2 Polycarbonate + Acrylonitrile butadiene styrene blend (PC+ ABS)

A compounded blend of polycarbonate and ABS. the PC contribute impact and heat distortion resistance, while the ABS contributes processability and chemical stress resistance and cost reduction below PC. [10]

Table 2.2: General properties of Polycarbonate+ Acrylonitrile Butadiene Styrene

General properties of PC+ABS	
Specific gravity	1.07
Tensile modulus @73 °F (MPsi)	0.8
Tensile strength @yield (Kpsi)	9.8
Notch izod impact @73 °F (ft-lb/in)	3.4-6.4
Thermal limits service temp (°F)	180-206
Shrinkage (%)	0.3-0.5
Tg(°F)	210-235
Process temp, (°F)	460-541
Mold temp, (°F)	154-193
Drying temp, (°F)	192-216
Drying time,(s)	2.0-4.0

Source: Campo (2006)

2.3.3 Polycarbonate (PC)

Polycarbonate is an amorphous engineering thermoplastic material with exceptional high impact strength, transparency, high temperature resistance and dimensional stability. Polycarbonate has high corona resistance and insulation resistance properties, as well as a dielectric constant that is independent of temperature [10]

Table 2.3: General properties of Polycarbonate

General properties of PC	
Specific gravity	1.40
Tensile modulus @73 °F (MPsi)	1.25
Tensile strength @yield (Kpsi)	19
Notch izod impact @73 °F (ft-lb/in)	1.7-3.0
Thermal limits service temp (°F)	220-265
Shrinkage (%)	0.15-0.6
Tg(°F)	293-300
Process temp, (°F)	430-620
Mold temp, (°F)	175-220
Drying temp, (°F)	250-260
Drying time, (s)	2.0-4.0

Source: Campo (2006)

2.4 INJECTION MOLDING

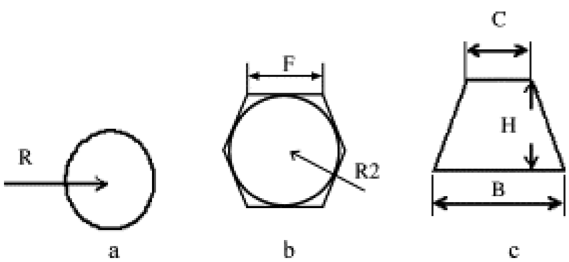
2.4.1 Thin wall molding

Thin wall molding is a high speed, high pressure injection molding process for producing parts with a nominal wall thickness less than 1.2mm or flow-length-to-wall-thickness ratios ranging from 100:1 to 150:1 or more. This process becomes increasingly important due to the economic advantages of using thin walls and the unpredicted growth of portable electronic and communication devices that require thinner, smaller and lighter housings. [11]

In thin wall molding, the packing pressure is the most influential factor. The second is mold temperature, followed by the melt temperature and the packing time. The less influential factors are the gate dimension and filling time. [12]

2.4.2 Runner layout

Depending on the requirement, many type of runner cross section can be used. The appropriate lengths and the areas of the cross sections are computer from this constant value of area by the equations given below: [14]



$$\text{(a) } A = \pi R^2 \tag{1}$$

$$\text{(b) } A = \frac{3FR_2}{2}, \quad R_2 = F\sqrt{3} \tag{2}$$

$$\text{(c) } A = \frac{(B+C) \times H}{2} \tag{3}$$

Source: Ozcelik (2005)

2.4.3 Undercut

Undercut features parameters are undercut feature volume and undercut feature direction. The undercut features can be determined based on the geometric entities of the undercut features, while undercut direction can be determined by the visibility map of the undercut surface. [15]

2.4.4 Cavity balancing

Cavity balancing is still one area that depends heavily on human interaction and input. The primary aim of cavity balancing is to fulfill the design criteria whereby the flow front of the plastic melt reaches the boundary or extremities of the mold at about the same with equal pressure. Balance flow is critical to the quality of the final product, as unbalanced flow during filling often leads to warping. [16]

2.5 MOLDFLOW

Moldflow Plastic Insight (MPI) software is an integrated suite of analysis tools that utilize CAD files and apply advanced Finite Element Analysis (FEA) techniques to quickly and easily enable a virtual design environment before initiating mold construction.

2.5.1 Gate location

The placement of gate in an injection mold is one of the most important variables of the total mold design. The quality of the molded part is greatly affected by the gate location, because it influences the manner in which the plastic flows into the mold cavity. Some defects, such as overpack and warpage can be effectively controlled by the gate location. Therefore, product quality can be greatly improved by having an optimum gate location. [17]Proper gate location leads to a better resin flow and shorter hesitation time. [18]

The success of filling and curing stages in liquid composite (LCM) depends in many variables such as location of gates and vents, temperature distribution, flow rate, injection pressure, etc. the process performance index based on gate-distance of the resin located on the flow front at different time steps. A good process should have short filling time and a vent –oriented flow with a desired resign flow pattern. At a given time step, the distances from the nodes located on the resin flow front to the outlet are associated with the quality of the filling process. The standard deviation of those distances is used to evaluate the shape of the flow front (the smaller the better). [19]

2.5.2 Fill time

The fill time represent the behavior of the melt polymer at regular intervals. Thermoplastic flow inside the mold using calculates a flow front that grows from interconnecting nodes at each element, starting at the injection nodes.[20]

2.5.3 Warpage

Warpage is the result of differential shrinkage. If the shrinkage of a material were completely isotropic with respect to thickness, flow direction and distance and pack pressure, plastic part would not warp. [21]

The small packing pressure can lead to high warpage value. The increasing of melt temperature can causes a decreasing on warpage.[22]

Mold thicknesses have an effect on the warpage of the part. The graph shows that the thicker package reduces warpage, because of the rigidity of the package increases. [23] The residual warpage on part can be decreased using an additional film on top of the package or by increasing the mold thickness.[24]

Thermal warpage resulting from unbalanced cooling in a flat plate of amorphous polymer. The thinnest part warps the greatest amount because its relatively small second moment of area in bending. The warpage is predicted from the temperature difference between the upper and lower surfaces, the temperature distribution, flow-induced shear stress, shrinkage, and anisotropic mechanical properties caused by fiber orientation. Higher shear stress on the material and more molecular orientation will be expected contribute to warpage. The higher L: T (length to thickness) ratio will also result in more warpage[25]

CHAPTER 3

METHODOLOGY

3.1 FLOW CHART/ PROJECT FLOW

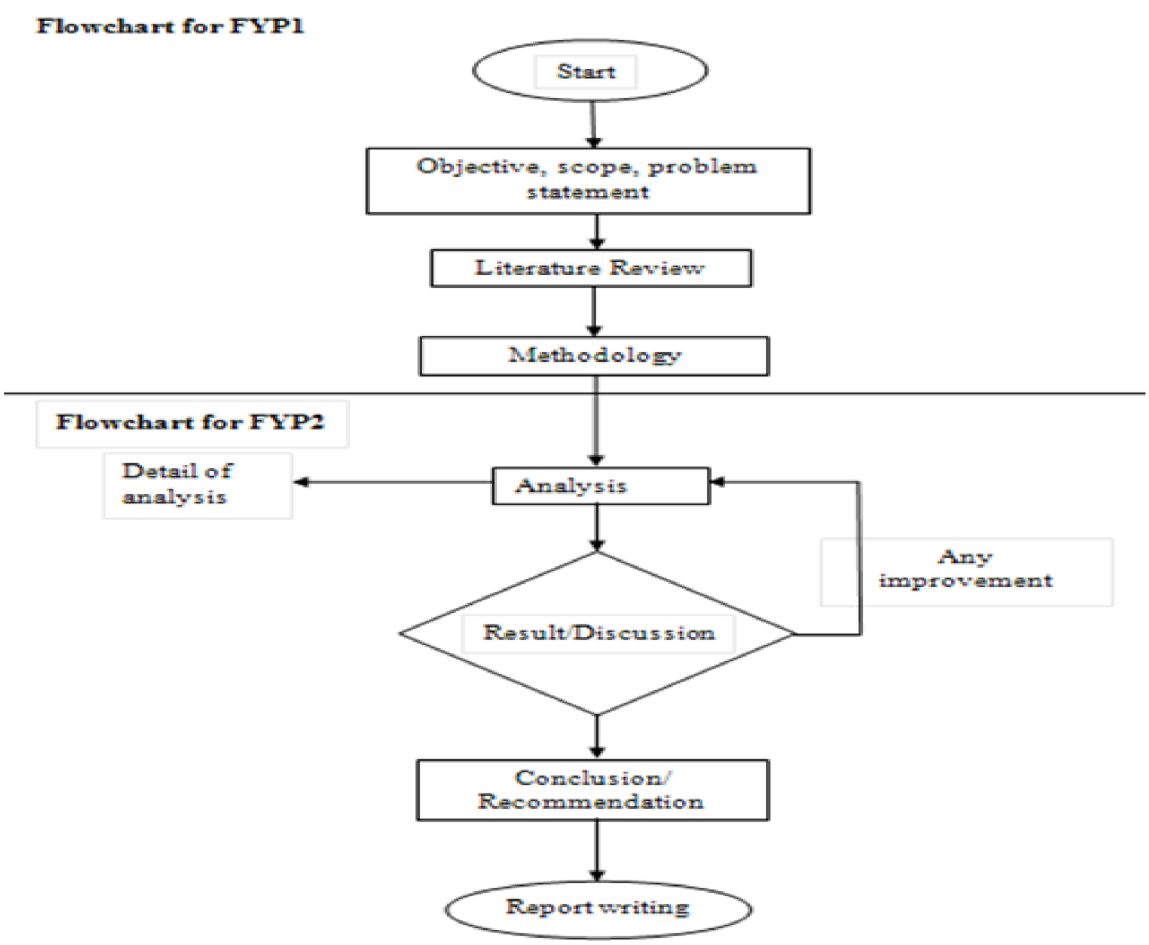


Figure3.1: Project flow chart for FYP1 and FYP2

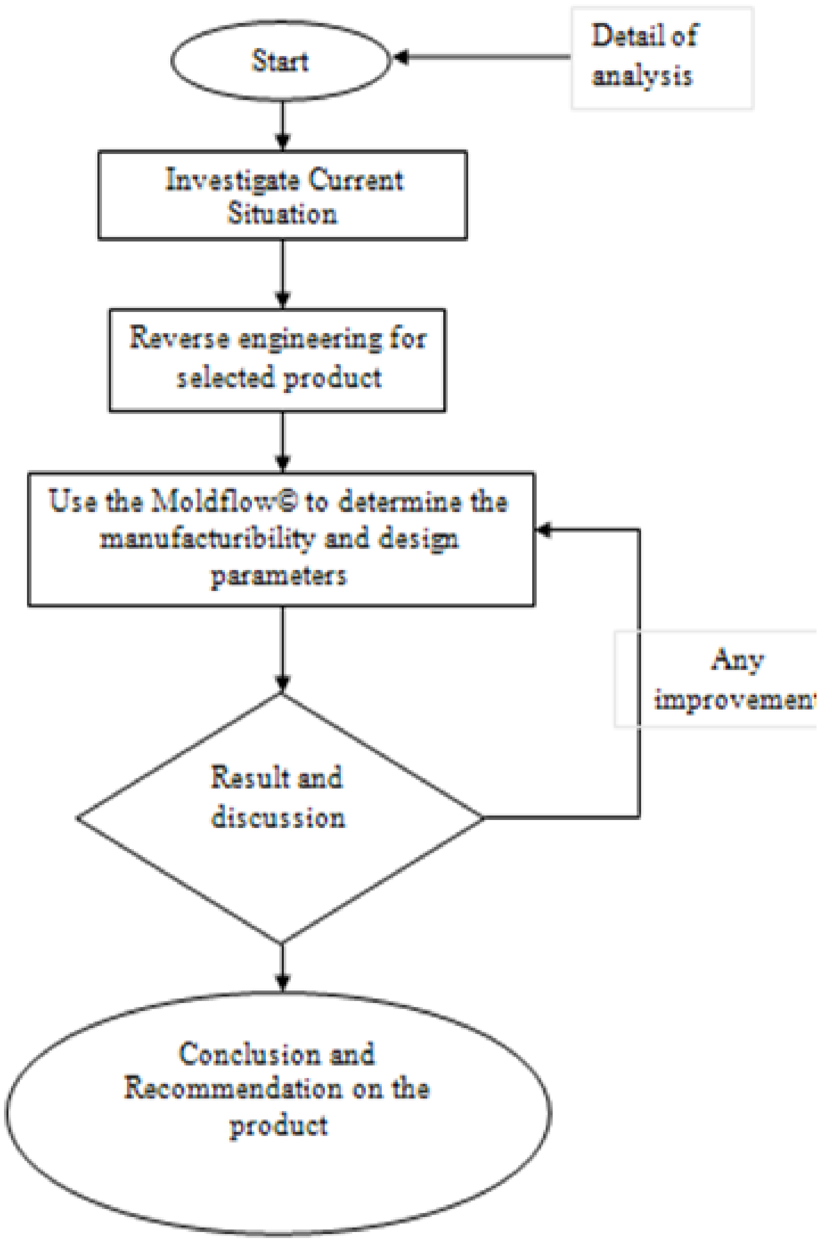


Figure 3.2: Project Flow Chart for Detail of Analysis

3.2 RECEIVED FYP TITLE

After received the title of final year project, my supervisor and I make discussion about it. We discuss about problem statement, objective and scopes of work of this project.

3.3 LITERATURE REVIEW

After discuss about the project detail, I make a literature review. I got the information about the project in journal, book and others project.

3.4 METHODOLOGY

Methodology is a important element in a project where it specifically describes the method to be used in the project. It is also can be a guideline to ensure we are following the project flow that we have planned at the beginning. Methodology also will help in order to make sure that the research run smoothly until we get the result and achieve the project objective.

3.4.1 Analysis Current Situation

Before getting start to make analysis, I make some review on current situation like the material that commonly use in production of handset casing, the latest innovation and the problem that being face by selected model. I choose NOKIA 1100 casing as my model.